# Spectrophotometric analysis of fluorescent zirconia abutments compared to ”conventional” zirconia abutments: A within subject controlled clinical trial

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# Spectrophotometric analysis of fluorescent zirconia abutments compared to "conventional" zirconia abutments: a within subject controlled clinical trial

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Key words: ceramic abutments, dental abutments, dental implants, zirconia, crowns

Running head: Esthetics of fluorescent zirconia abutments

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**Author Contributions:**

| | | |
|---|---|---|
| 1) Concept/Design<br>2) Data analysis/interpretation<br>3) Drafting article<br>4) Critical revision of article<br>5) Approval of article<br>6) Statistics<br>7) Funding secured by<br>8) Data collection | Daniel S. Thoma:<br>Felix B. Gamper:<br>Vítor M. Sapata:<br>Giuseppe Voce:<br>Christoph H.F. Hämmerle:<br>Irena Sailer: | 1-8<br>2,3,4,5, 8<br>2,3,4,5, 8<br>2,3,4,5, 8<br>1, 2,3,4,5,7<br>1, 2,3,4,5, 6, 7 |

# Abstract

**Background:** Zirconia abutments are frequently used for implant-supported single crowns. Even though demonstrating esthetic benefits compared to metal abutments, zirconia abutments lead to an increased brightness of the peri-implant mucosa compared to natural teeth and are not ideal from an esthetic point of view.

**Purpose:** To test whether or not a fluorescent hybrid zirconia abutment offers superior esthetics compared to a non-fluorescent one-piece zirconia abutment based on spectrophotometric analysis.

**Materials and Methods:** In 24 patients with 24 single-tooth implants, two types of reconstructions were fabricated: a directly veneered one-piece zirconia abutment/crown (control) and a directly veneered fluorescent hybrid zirconia abutment/crown (test). Spectrophotometric assessment was performed: prior to abutment insertion (WA), at abutment try-in (A), at the try-in of the final crowns (C). Color differences ($\Delta E$) were assessed compared to the gingiva of natural teeth (T) and between the reconstructions.

**Results:** At abutment try-in, $\Delta E$ values were 8.49±3.59 for $A_{Control}$ and 8.27±4.03 for $A_{Test}$ compared to T. At crown insertion, $\Delta E$ values were 7.61±4.03 for $C_{Control}$ and 8.32±3.57 for $C_{Test}$ compared to T. The difference in $\Delta E$ values between $A_{Control}$ and $A_{Test}$ was 0.23±2.54 (p=0.37), whereas the difference in $\Delta E$ values between $C_{Control}$ and $C_{Test}$ was -0.66 ±3.45 (p=0.48). For all cases with a mucosal thickness ≤2mm, the comparison between $C_{Control}$ and $C_{Test}$ was significant in favor of the control group (p=0.03).

**Conclusions:** Both types of reconstructions were similar in terms of esthetics. Incases with a mucosal thickness of <2mm, the soft tissue discoloration compared to

the natural gingiva was more pronounced for the fluorescent hybrid zirconia reconstructions.

# Introduction

Implant-supported single crowns have become a valid alternative to conventional fixed dental prostheses demonstrating similar clinical long-term results [1, 2]. Most of the long-term data are derived from clinical studies using metal abutments, which, from an esthetic point of view, are associated with a greyish and dark discoloration at implant sites with a thin peri-implant mucosa [3, 4].

Numerous studies showed that ceramics made of high strength zirconia are highly biocompatible [5-9]. The biologic behavior appears to be superior to metals since ceramics do not suffer from corrosion and/or galvanic coupling. Favorable biocompatibility with respect to hard and soft tissues was reported using zirconia ceramics [10, 11]. Moreover, the white color of zirconia abutments can reduce the discoloration of the peri-implant mucosa and therefore offer an esthetic benefit compared to titanium abutments [3, 7]. An experimental study, however, indicated that the use of white, rather opaque, zirconia as abutment material induced too much brightness onto the soft tissues. This resulted in suboptimal esthetic outcomes. [4].

Various approaches were pursued in the past to further optimize the esthetic outcomes through modifications of zirconia abutments [12-15]. A retrospective study indicated that a fluorescent veneering ceramic covering the white zirconia abutments improved the esthetic outcome with respect to brightness [16]. According to this clinical study, the use of zirconia abutments with a high translucency appears to be beneficial in terms of esthetics as demonstrated by an increased brightness and lower L, a and b values at the peri-implant mucosal margin compared to natural tooth sites. This has been further documented in a recent in vitro study [17]. In that study, various materials were evaluated for their influence on the discoloration of the mucosa. The use of a fluorescent zirconia material demonstrated to be the most promising material even in cases with a thin mucosa since an increased light

transmission into the soft tissues might be expected and, compared to zirconia abutments, a reduced opacity [16, 17]. Clinical data for the use of fluorescent zirconia as an abutment material for dental implants is lacking. Moreover, the clinical and esthetic benefit compared to traditional white zirconia abutments remains unknown.

The aim of the present study was, therefore, to test whether or not a fluorescent zirconia abutment offers superior peri-implant soft tissue esthetics compared to a non-fluorescent zirconia abutment based on spectrophotometric evaluation of the soft tissue color differences.

# Materials and methods

*Study design and subjects*

This study was designed as a single center, controlled clinical trial. Upon approval by the local ethics committee (Ref. KEK-ZH-Nr. 2013-431), 24 healthy patients were enrolled in the study. The number of patients was determined based on a previously published 5-year randomized controlled clinical trial with a similar analysis, but two different treatment modalities [18]. In the present study, a within-patient controlled design was chosen. Therefore, the subject number was reduced, yet, taking into account a 20% drop-out rate.

The following inclusion criteria were applied: patients with an age between 18 and 80 years; single-tooth two-piece implant with non-matching implant abutment junction (Bone level implant, Institut Straumann AG, Basel, Switzerland) in the anterior maxilla or mandible (incisors, canines, premolars); at least one natural neighboring tooth present and, signed informed consent. The exclusion criteria were: smoking more than 10 cigarettes a day, probing pocket depth values >3mm, poor oral hygiene (plaque index >20%), signs of bruxism and pregnancy at the date of inclusion.

*Fabrication of reconstructions*

For each implant site two zirconia abutments were made with the aid of a computer-assisted design/computer-assisted manufacturing (CAD/CAM) procedure. The submucosal space for the veneering ceramic was defined by standardized reduction of the abutment design of 0.5 mm. All reconstructions were made by one single dental technician (GV). All abutments (test and control) were directly veneered with fluorescent feldspathic veneering-ceramic (Creation ZI-CT, Creation Willi Geller International GmbH, Meiningen, Austria). The veneering ceramic encompassed the entire crown, but did not extend more apically than 0.5mm below the mucosal margin.

In the control group, the one-piece zirconia abutments (Cares abutment, Institut Straumann AG, Basel, Switzerland) were directly veneered resulting in a one-piece screw-retained implant crown. In the test group, the fluorescent zirconia abutment was directly veneered and then extra-orally cemented (Panavia 21®, Kuraray Medical Inc., Okayama, Japan) on a titanium base (Zirkon, Medentika Gmbh, Hügelsheim, Germany) resulting in a hybrid abutment screw-retained implant crown.

*Clinical protocol*

Following the final impression on the implant level, two types of screw-retained reconstructions were fabricated for each patient/site:

- Test: a directly veneered reconstruction on a fluorescent zirconia abutment, cemented on a titanium base, resulting in a fluorescent screw-retained implant crown (3M ESPE Deutschland GmbH, Seefeld, Germany)
- Control: directly veneered one-piece non-fluorescent zirconia abutment resulting in a non-fluorescent screw-retained one-piece implant crown (Cares abutment, Institut Straumann AG, Basel, Switzerland)

The horizontal and vertical position of the abutment shoulder and dimensions of the abutment were checked in a clinical try-in. The abutment shoulder was positioned 0.5 mm below the mucosal margin and at least 0.5mm of remaining inter-occlusal space between the abutment and the antagonistic tooth. A fluorescent feldspathic ceramic was applied on the abutments and a biscuit bake try-in was done for final adjustments. Both types of reconstructions were then finalized and a try-in appointment scheduled. Finally, at all implant sites, the test reconstructions were inserted and patients included in a regular maintenance program. All follow-up examinations were performed at the Clinic of Fixed and Removable Prosthodontics and Dental Material Science, University of Zurich, Switzerland.

*Esthetic assessment*

One blinded examiner performed all the measurements. A spectrophotometer (Spectroshade, MHT Optic Research AG, Niederhasli, Switzerland) was used to evaluate the influence of the reconstructions on the color of the peri-implant tissues [12]. Spectrophotometric assessments were performed 1 mm below the gingival/mucosal margin at the implants site and the natural neighboring tooth site. The implant site and the neighboring tooth site were evaluated preceding the abutment try-in (without abutment; WA), after the abutment try-in (both treatment modalities; A) and after the final reconstruction try-in (both treatment modalities; C). All spectrophotometric measurements were made as soon as the ischemic area around the implant site disappeared. The data of each color measurement was expressed using the CIE-LAB parameters (Commission Internationale de l'Eclaire; L= lightness, a=chroma along red-green axis, b=chroma along yellow-blue axis). All measurements were repeated three times and mean values calculated. The differences (ΔL, Δa, Δb) were converted into the overall color difference ΔE using the following equation:

$$\Delta E = \sqrt{\left(\Delta L^2 + \Delta a^2 + \Delta b^2\right)}$$

The calculated color differences (ΔE) for each group included:

i) Neighboring tooth (T) versus implant site without abutment (WA)

ii) Neighboring tooth (T) versus implant site with abutments ($A_{Control}/A_{Test}$)

iii) Neighboring tooth (T) versus implant site with final reconstruction ($C_{Control}/C_{Test}$)

Moreover, color differences (ΔE) were calculated between test and control groups for:

i) Implant site with abutment versus without abutment ($A_{Control}/A_{Test}$ vs. WA)

ii) Implant site with control abutment ($A_{Control}$) versus test abutment ($A_{Test}$)

iii) Implant site with control final reconstruction ($C_{Control}$) versus test final reconstruction ($C_{Test}$)

In addition, the thickness of the mucosa at the implant site and the gingiva of contra-lateral tooth were assessed to the nearest 0.5mm. For that purpose, an endodontic file with a rubber stop was used at a level 1mm below the gingival/mucosal margin on the buccal side of the implant/tooth.

*Statistical analysis*

For data description, mean and standard deviation, median and quartiles for metric variables as well as frequencies and percentages for categorical parameters are presented. The mean, median and standard deviation are mentioned in the text and the other measures in the tables. For the comparison of two groups a nonparametric test was applied because of the small sample size. The Wilcoxon signed rank test was used for dependent groups and the Mann-Whitney test for independent groups, which compare medians. The assumptions of these tests were checked in the applications. Moreover, groups formed by the mucosal thickness with >2mm and with less than 2mm were compared. The level of significance was set at 5%.

## Results

In all 24 patients, the planned types of reconstruction were fabricated and esthetic analyses performed.

Tables 2-4 present the detailed spectrophotometric data. The comparison between the neighboring tooth (T) and the implant site without abutment (WA) rendered a ΔE of 8.58±4.03 (median 8.02). Following the insertion of an abutment, ΔE values (compared to the control tooth) were 8.49±3.59 (median 8.00) for $A_{Control}$ and 8.27±4.03 (median 7.40) for $A_{Test}$. At the day of crown insertion, ΔE values (compared to the control tooth) were 7.61±4.03 (median 6.78) for $C_{Control}$ and 8.32±3.57 (median 7.74) for $C_{Test}$. No statistically significant differences were calculated for any of the comparisons ($p>0.05$).

The difference between the implant site without abutment (WA) and the implant site with abutment ($A_{control/Test}$) amounted to 0.09±5.54 (median 0.32) for $A_{Control}$ ($p=0.60$) and 0.32±5.46 (median 0.88) for $A_{Test}$ ($p=0.45$). The difference between $A_{Control}$ and $A_{Test}$ was 0.23±2.54 (median 0.25) ($p=0.37$), whereas the comparison between $C_{Control}$ and $C_{Test}$ revealed a difference of -0.66±3.45 (median -0.50) ($p=0.48$).

Table 4 presents ΔE values depending on the mucosal thickness (≤2 mm vs >2 mm). The comparison between $C_{Control}$ and $C_{Test}$ (-2.08±3.82 (median -1.34) for ≤2mm and 0.75±2.30 (median 0.28) for >2mm presented a statistically significant difference in favor of the control group ($p=0.03$) in cases with a mucosal thickness of ≤2mm. No significant differences were found for the comparisons at abutment try-in ($p=0.88$) and for implant sites without abutments (WA) compared to implant sites with abutments ($A_{control/Test}$; $p=0.60/p=0.78$).

## Discussion

The present study demonstrated no statistically significant differences between fluorescent zirconia abutments cemented on titanium bases and non-fluorescent one-piece zirconia abutments in terms of peri-implant soft tissue esthetics. In addition, if the thickness of the mucosa was taken into account, the one-piece zirconia abutment led to significantly improved esthetics at implant sites with a thin mucosa (<2mm).

Zirconia abutments exhibit adequate mechanical strength and may serve as an alternative to metal abutments for specific clinical indications [19-21]. One has to bear in mind, though, that the stability of zirconia abutments is significantly influenced by the type of implant- abutment connection. Laboratory studies indicated that, for implants with an internal implant-abutment connection, two-piece zirconia abutments with a secondary metallic coupling or a hybrid abutment for the internal connection exhibited a significantly higher strength than one- piece zirconia abutments [19, 22].

More recently, a pre-fabricated new titanium hybrid abutment, the titanium base, was introduced offering new restorative possibilities. This new type of prosthetic implant component can be used as a support for custom-made implant abutments and/ or crowns made by means of CAD/CAM technology out of various materials. After the fabrication and refinement, the CAD/CAM abutment or reconstruction is adhesively cemented onto the titanium base and the resulting restoration is screw-retained on the implant. Since this concept is rather versatile, all major implant manufacturers offer titanium bases and allow for the connection of different CAD/CAM components to the implants. The titanium bases enable to connect an esthetic customized zirconia abutment to a stable titanium substructure and, thereby, to combine the esthetic benefits of ceramics with the stability of the metals [23, 24].

Esthetic benefits of the “conventional” white zirconia abutments compared to metal abutments include less discoloration of the peri-implant soft tissues most specifically in situations with thin tissues [25, 26]. Still, even zirconia abutments may lead to a discoloration of the peri-implant mucosa. It has been shown that the bright white zirconia increased the lightness of the soft tissues (higher L values) leading to a blenching of the peri-implant mucosa. This “discoloration” is less esthetically problematic than the grayish discoloration caused by the metal abutments. Still, further improvements of zirconia abutments are desirable in terms of esthetics.

In a laboratory study, a positive effect of fluorescent zirconia on the soft tissue color was reported [27]. The aim of the present study was, therefore, to combine the esthetic benefits of fluorescent zirconia abutments with the stability of a titanium base and compare the peri-implant soft tissue color outcomes to the ones around “conventional” non-fluorescent one-piece zirconia abutments. Within this investigation, the fluorescent zirconia abutments were combined with titanium hybrid abutments. Hybrid abutments exhibit superior mechanical properties [28] and may overcome limitations of one-piece zirconia abutments, like the relatively high rate of technical complications already occurring within short clinical observation periods of 1 year [15],.

For the present esthetic analysis, a well documented spectrophotometer (Spectroshade, MHT) was used for the comparisons of the soft tissue color. The color parameters of the tested sites were measured and color differences ΔE were calculated. In order to determine whether or not the color differences were visible by the naked eye and in consequence clinically relevant previously published threshold values for the visibility of color differences (ΔE) by the naked human eye were applied as reference [29]. The threshold values, calculated for the perception of color changes of the human gingiva, ranged between ΔE 1.6 ± 1.1 (dental technicians) and ΔE 3.4 ± 1.9 (lay people) and were reported to have a

mean ΔE of 3.1 [29]. Hence, the mean ΔE threshold value of 3.1 was taken into account when analyzing color differences between different abutments.

The comparative analysis between the two groups at different stages (with abutment, with crown) in the present study demonstrated no significant differences between the groups. The fluorescent abutments, hence, did not exhibit esthetic advantages over the "conventional" white zirconia abutments. ΔE values varied less than 0.66 at the final crown insertion. Overall, the lack of significant spectrophotometric differences between groups has been reported earlier comparing metal abutments to zirconia abutments or different types of zirconia abutments [7, 12, 14]. Moreover, in the present study, ΔE values at crown insertion were 8.32 for test and 7.61 for control, resulting in a clinically visible difference for both groups compared to the contra-lateral natural tooth site.

Besides the implant [10, 30] or abutment material [25, 26], the thickness of the mucosa is reported to have a significant influence on the discoloration of the peri-implant mucosa [7, 30, 31]. This phenomenon corroborates with the findings of the present study. When the comparisons were made according to the mucosal thickness (<2mm and >2mm), the patients with more than 2mm of mucosal thickness presented no significant differences between the groups. In patients with <2mm of mucosal thickness, the peri-implant mucosa (after the insertion of the final reconstruction) demonstrated a decrease in lightness of the soft tissues using the fluorescent hybrid zirconia abutment (lower L values) compared to the "conventional" one-piece zirconia abutment (higher L values). The difference of ΔE 2.08 was statistically significant. Considering the threshold values to detect a discoloration (increase in brightness) of the mucosa, this difference between the groups might not be visible to lay people (ΔE 3.4±1.9). Yet, professionals like dentists (ΔE 2.7±1.0) and dental technicians (ΔE 1.6±1.1) may see the difference and, for this reason, might prefer the "conventional" one-piece zirconia abutment. Previously, a positive effect of fluorescence on spectrophotometric

differences has been shown in two in vitro studies [17, 27]. These studies evaluated the effect of materials on the color of the mucosa by placing different fluorescent and non-fluorescent materials under soft tissue flaps with 1.5mm thickness in pig jaws. Thereafter, the color of the soft tissue was measured [27]. Both studies reported favorable esthetic outcomes for the fluorescent materials. In a clinical study, zirconia abutments were veneered with a 2mm-wide layer of fluorescent light orange dental ceramic. Subsequently, all-ceramic crowns were fabricated and cemented on top of the abutments [16]. The data demonstrated in 5 out of 12 cases, no differences of the peri-implant mucosal color compared to the natural gingiva around control teeth.

In the present study, a titanium base was used to support the zirconia abutment. The test zirconia abutments although being fluorescent failed to induce better peri-implant soft tissue esthetics compared to one-piece control zirconia abutments. One possible explanation for this unexpected phenomenon may be the showing through of the grayish-metallic titanium base through the thin fluorescent zirconia abutment, leading to a general decrease in lightness of the abutment, which in consequence led to a decrease in lightness of the soft tissues. In sites with minor differences of the cross section of the implant/ titanium base and the tooth to be replaced, the thickness of the fluorescent zirconia abutment was limited through the standardized size of the screw access cylinder of the titanium base. In the present study, a translucent resin cement was used for the fixation of the fluorescent zirconia abutments to the titanium base. This cement was not able to masque the grey color of the metal. Opaque resin cements should be preferred in this specific indication to reduce the risk for discoloration.

The outcomes of the present study are limited to some extent by the study design. Since two types of abutment designs were used (hybrid vs. one-piece), the effect of

fluorescence per se could not be assessed in a standardized way. Yet, the effect of screw-retained implant crowns supported by fluorescent zirconia abutments and a titanium base on the soft tissue color was compared to screw-retained implant crowns supported by “conventional” white zirconia abutments. Hence, several factors were included in the present test. Keeping this limitation in mind, future research is needed to analyze a possible effect of the titanium base on various ceramic restorations, thereby analyzing the effect of fluorescence as a single confounding factor.

# Conclusions

The fluorescent hybrid zirconia abutment did not lead to a significant improvement of the esthetic outcomes compared to the “conventional” non-fluorescent one-piece zirconia abutments based on all included patients and implant sites. In addition, in cases with a mucosal thickness of <2mm, the “conventional” control group exhibited significantly better esthetics. The outcomes are limited to some extent by the fact that two types of abutment designs were used (hybrid vs. one-piece). The effect of fluorescence per se could not be assessed.

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# Figure legends

Figure 1. Clinical case with a central incisor having been replaced with a dental implant. A) clinical view without abutment. B) Try-in of control abutment. C) Try-in of test abutment. D) Final reconstruction (control) (left) and final reconstruction (test) (right). E) Final reconstruction (test). F) Final reconstruction (control).

Table 1. Implant distribution with implant location and diameter in all 24 patients.

Table 2. Descriptive statistics for spectrophotometric measurements. T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth

Table 3. Comparisons without grouping. T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth

Table 4. Comparisons with grouping according to mucosal thickness (MT) (≤2mm and >2mm). T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth

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Figure 1

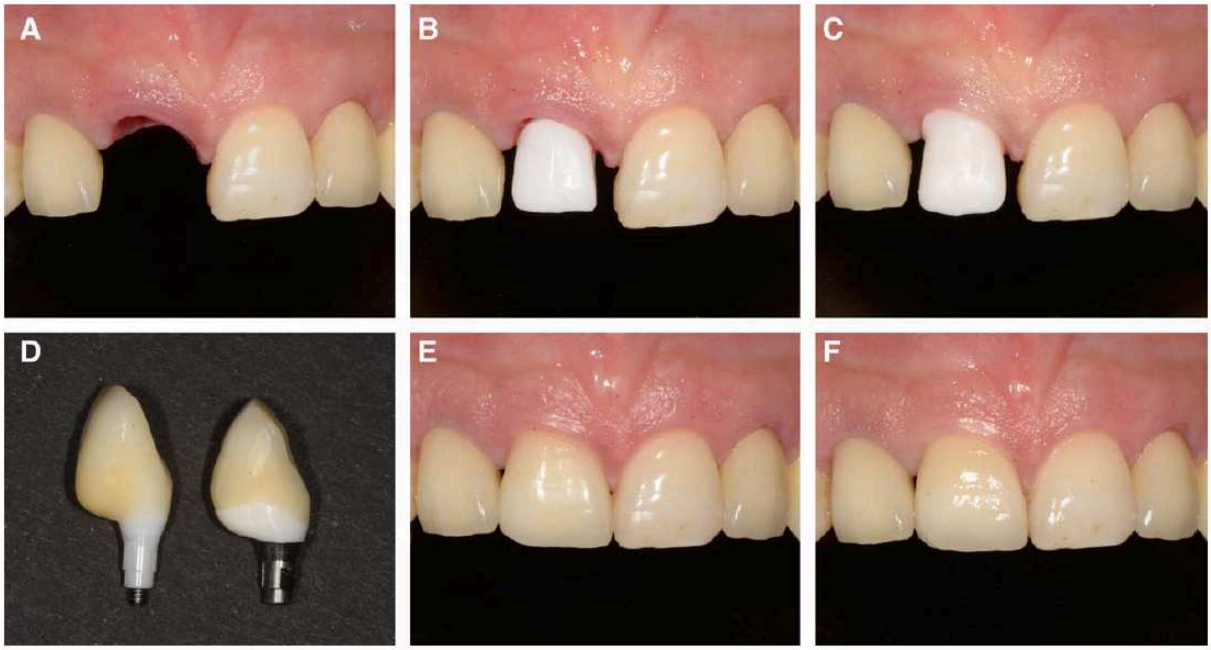

Table 1. Implant distribution with implant location and diameter in all 24 patients

| Subject Number | Implant Diameter [mm] | Jaw | Location |
|---|---|---|---|
| 1 | 4,1 | Maxilla | 14 |
| 2 | 4,1 | Maxilla | 15 |
| 3 | 3,3 | Maxilla | 15 |
| 4 | 4,1 | Mandible | 45 |
| 5 | 4,1 | Mandible | 35 |
| 6 | 4,1 | Mandible | 35 |
| 7 | 4,1 | Maxilla | 24 |
| 8 | 3,3 | Maxilla | 25 |
| 9 | 4,1 | Mandible | 45 |
| 10 | 4,1 | Maxilla | 25 |
| 11 | 3,3 | Mandible | 35 |
| 12 | 4,1 | Maxilla | 15 |
| 13 | 4,1 | Maxilla | 14 |
| 14 | 3,3 | Maxilla | 15 |
| 15 | 4,1 | Maxilla | 24 |
| 16 | 4,1 | Mandible | 45 |
| 17 | 4,1 | Maxilla | 15 |
| 18 | 4,1 | Maxilla | 11 |
| 19 | 3,3 | Maxilla | 25 |
| 20 | 4,1 | Maxilla | 25 |
| 21 | 3,3 | Maxilla | 14 |
| 22 | 4,1 | Maxilla | 15 |
| 23 | 4,1 | Maxilla | 24 |
| 24 | 4,1 | Maxilla | 21 |

Table 2. Descriptive statistics

| | Mean | SD | Q1 | Median | Q3 |
|---|---|---|---|---|---|
| **Δ**E T vs WA | 8,58 | 4,03 | 5,69 | 8,02 | 11,39 |
| **Δ**E T vs $A_{Control}$ | 8,49 | 3,59 | 6,08 | 8,00 | 9,41 |
| **Δ**E T vs $A_{Test}$ | 8,27 | 4,03 | 5,24 | 7,40 | 10,08 |
| **Δ**E T vs $C_{Control}$ | 7,61 | 4,03 | 4,75 | 6,78 | 8,94 |
| **Δ**E T vs $C_{Test}$ | 8,32 | 3,57 | 5,21 | 7,74 | 11,27 |

T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth

Table 3. Comparisons without grouping

| | Mean | SD | Q1 | Median | Q3 | p |
|---|---|---|---|---|---|---|
| $A_{Control}$ vs WA | 0,09 | 5,54 | -2,12 | 0,32 | 3,95 | 0,60 |
| $A_{Test}$ vs WA | 0,32 | 5,46 | -2,27 | 0,88 | 4,08 | 0,45 |
| $A_{Control}$ vs $A_{Test}$ | 0,23 | 2,54 | -0,89 | 0,25 | 2,11 | 0,37 |
| $C_{Control}$ vs $C_{Test}$ | -0,66 | 3,45 | -3,05 | -0,50 | 1,57 | 0,48 |

T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth

Table 4. Comparisons with grouping according to mucosal thickness (MT) (≤2mm and >2mm)

| | ≤2mm | | | | | >2mm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Q1 | Median | Q3 | Mean | SD | Q1 | Median | Q3 | p |
| $A_{Control}$ vs WA | 0,73 | 5,97 | -3,39 | 2,14 | 4,08 | 0,41 | 3,91 | -0,76 | 0,00 | 1,48 | 0,60 |
| $A_{Test}$ vs WA | 0,87 | 5,79 | -1,22 | 1,67 | 4,44 | 0,53 | 4,63 | -0,17 | 0,79 | 3,33 | 0,78 |
| $A_{Control}$ vs $A_{Test}$ | 0,14 | 2,10 | -0,29 | 0,37 | 1,31 | 0,12 | 3,17 | -2,03 | 0,08 | 3,03 | 0,88 |
| $C_{Control}$ vs $C_{Test}$ | -2,08 | 3,82 | -4,15 | -1,34 | -0,64 | 0,75 | 2,30 | -0,03 | 0,28 | 1,57 | 0,03 |

T: Tooth; WA: Without Abutment; A: Abutment; C: Contralateral tooth